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Efficacy of the resilience and adjustment intervention after traumatic brain injury: a randomized controlled trial

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ABSTRACT

Objective: Examine a psychoeducational and skill-building intervention's effectiveness for individuals after traumatic brain injury (TBI), using a two-arm, parallel, randomized, controlled trial with wait-listed control.

Methods: The Resilience and Adjustment Intervention (RAI) targets adjustment challenges and emphasizes education, skill-building and psychological support. Overall, 160 outpatients were randomly assigned to a treatment or wait-list control (WLC) group. The manualized treatment was delivered in seven 1-h sessions. The Connor-Davidson Resilience Scale (CD-RISC) was the primary outcome measure. Secondary measures included the Mayo Portland Adaptability Inventory-4 (MPAI-4), Brief Symptom Inventory-18 (BSI-18) and 13-Item Stress Test.

Results: After adjusting for injury severity, education and time postinjury, the RAI group (*N* = 75) demonstrated a significantly greater increase in resilience (effect size = 1.03) compared to the WLC group (*N* = 73). Participants in the RAI group demonstrated more favourable scores on the MPAI-4 Adjustment and Ability Indices, BSI-18 and the 13-item Stress Test. However, only the CD-RISC and BSI-18 demonstrated a clinically significant difference. In addition, RAI participants demonstrated maintenance of gains from pre-treatment to 3-month follow-up; however, only the BSI-18 maintained a clinically significant difference.

Conclusions: Investigation provided evidence that a resilience-focused intervention can improve psychological health and adjustment after TBI. Additional research is needed to ascertain the longer term benefits of intervention and the efficacy of alternative delivery methods (e.g., via telephone, Internet).

Introduction

Persons with traumatic brain injury (TBI) across all degrees of injury severity often struggle with cognitive (1,2), emotional (3,4), psychological (5,6) and psychosocial (7,8) challenges, some for the remainder of their lives. A broad range of rehabilitation interventions has been designed in efforts to mitigate obstacles to complete recovery (9–16). However, concerns about efficacy remain. Frequently, intervention outcomes are limited to specific domains (10,16), generate non-transferable skills (15,17), cannot be reproduced (18,19) or show transitory gains (9). Without treatment approaches that can produce sustainable, holistic gains, individuals with TBI will continue to struggle to establish productive and meaningful lives postinjury.

A recent paradigm shift in the field of psychology has led clinical researchers to explore the relationship between resilience and trauma outcomes (20,21). Resilience has been defined as "positive adaptation in the face of a traumatic event" (22). The exploration of resilience began with the study of individuals who emerged from traumatic situations unharmed and even strengthened (23,24). These individuals were found to possess certain critical skills. Although many of the skills associated with resilience correspond with seemingly static personality characteristics, a key feature of resilience lies in the distinction between skills and

traits (20). Traits are innate. On the other hand, skills can be promoted and developed throughout the life span.

Researchers have observed fundamental skills in resilient individuals, including effectively managing emotions, maintaining a positive outlook, adaptive problem solving and effective communication (25). Researchers have also discovered that the skills associated with a resilient and adaptive response to trauma are not extraordinary. In fact, resilient skills can be taught and/or enhanced in individuals who have previously demonstrated non-resilient profiles (22,26).

There is a growing body of research that indicates a relationship between resilience, preinjury factors and postinjury outcomes. In 2016, a TBI Model System multi-centre study examined resilience at three months postinjury among a sample of adults with moderate to severe TBI. The investigation yielded evidence that resilience levels were relatively low in comparison to the general population (27). Investigators also showed that greater resilience was related to higher education, absence of preinjury substance abuse and lower anxiety. In the same year, Hanks and colleagues reported on resilience within 5 years following mild, moderate and severe injury (28). Generally, resilience was unrelated to injury or demographic factors, although the relationship to education approached significance, with higher education levels predicting greater resilience.

In a series of recent studies, Losoi and colleagues (29–31) and Sullivan and colleagues (32) examined resilience in patients with mild TBI. Greater resilience was associated with fewer post-concussion symptoms and better quality of life. Sullivan, in a later systematic review, reaffirmed that higher levels of resilience were associated with fewer post-concussion symptoms (33). Another recent investigation (21) examined the relationship between resilience, emotional distress and participation in a treatment-seeking, outpatient sample with mild, moderate and severe TBI. Lower levels of resilience were associated with greater psychological distress. The authors suggested that interventions that successfully target resilience are likely to benefit emotional well-being. In all, while resilience in individuals with TBI is a relatively new line of research, there is consensus that resilience is a quality likely to help mitigate emotional distress after TBI.

Given the long-term challenges of TBI, there is increasing recognition for the critical need to develop a resilience-building approach to treatment in brain injury rehabilitation settings (20,23,34,35). As such, the primary purpose of the present investigation was to conduct a randomized controlled trial designed to evaluate the efficacy of a structured, curriculum-based intervention to promote postinjury resilience and adjustment. The following hypotheses were proposed: (1) participants in the treatment group will report higher levels of resilience in comparison to individuals in the wait-list control (WLC) group; (2) participants in the treatment group will show better adjustment and lower levels of emotional distress as compared to persons in the WLC group; (3) participants in the treatment group will report greater abilities in the areas of problem solving, communication and stress management relative to persons in the WLC group; and (4) at three month follow-up, treatment group participants
will show sustained improvement in resilience, emotional well-being, adjustment and abilities. Specifically, differences between pre-treatment and 3-month follow-up were anticipated, but differences between post-treatment and follow-up data were not.

Methods

Participants

A total of 160 participants with TBI and at least 3 months postinjury were consented into the 2-arm parallel, wait-listed control, clinical trial between December 2012 and August 2016. Overall, 83 participants (52%) were randomized to the Resilience and Adjustment Intervention (RAI) group and the remaining 77 (48%) were randomized to the WLC group (see Figure 1). Eight of the 83 treatment subjects (10%) dropped out of the study prior to the post-treatment observation with one additional subject completing the post-treatment observation but missing the follow-up appointment. Only four of the 77 subjects (5%) in the WLC group did not attend their second baseline appointment. Enrolment into the study was suspended after the desired sample size was achieved.

Half of the participants were male (50%), 29% were married, and 71% were White. With regard to TBI severity, about one third (36%) had sustained a moderate or severe injury

(Glasgow Coma Scale, GCS 3–12). The remaining sustained mild (59%; GCS 13–15) injuries with 6% unknown. About half of the injuries were caused by motor vehicle accidents (51%) with a smaller number caused by falls (14%), motorcycle or bicycle accidents (12%), assaults (9%), pedestrian (6%), hit by falling or flying object (4%) or sports injuries (4%). Median time postinjury was 1.6 years (range: 3 months to 33 years). Information was collected on ancillary services received at the time of intervention. Table 1 provides additional descriptive information regarding participants.

Intervention structure and content

The RAI is a structured treatment programme designed to enhance individuals' resilience and adjustment after TBI via education, skill-building and psychological support. The intervention was designed to address the issues and concerns most often identified by persons with brain injury and most related to a resilient profile, including emotional regulation, stress management, problem solving and communication (34). The intervention protocol is implemented over the course of seven 1-h sessions. Sessions, topics and goals are displayed in Table 2.

To enhance resilience and facilitate adjustment, the RAI relies heavily on several specific therapy techniques including reframing, validation, empathic reflections and normalization. Underlying the RAI are the key tenants of Cognitive Behavioral Therapy (CBT) (36), which espouses the idea that a person's cognitions influence his or her emotions and behaviour. Change in one area is thought to produce reciprocal changes in the other areas of functioning. Research has substantiated the benefits of CBT after brain injury (37–39). As such, CBT techniques have been adapted and incorporated into the RAI to improve emotional, cognitive and behavioural functioning. Educational strategies were used to inform participants about injury sequelae and recovery. Psychological support techniques were used to help participants recognize their feelings and improve their emotional well-being. Skills training was incorporated to improve communication, problem-solving and emotional control. Bibliotherapy served as a useful complement. Fact sheets, guides and supplementary readings from the book *Getting Better and Better after Brain Injury: A Guide for Survivors* (40) were provided and reviewed by participants during each treatment session and for homework. Materials were organized in a binder that participants brought to each session. A learning survey was completed at the end of each session. Specifically, participants were asked to indicate the extent to which session goals were met. They were also asked to rate the helpfulness of each session.

Clinicians relied on the RAI manual (41) to provide the intervention efficiently and systematically. For each topic covered in each session, the manual details goals, materials, and, if needed, accommodations for disability. Using a step-by-step approach, the manual provides the clinician with detailed scripts for each topic, instructions for therapeutic activities and homework.

The four clinicians conducting the RAI were doctoral-level psychologists who received training from the first author. Initially, clinicians carefully studied the treatment manual and met regularly with the first author to address procedures, questions and concerns. Next, clinicians were observed and given
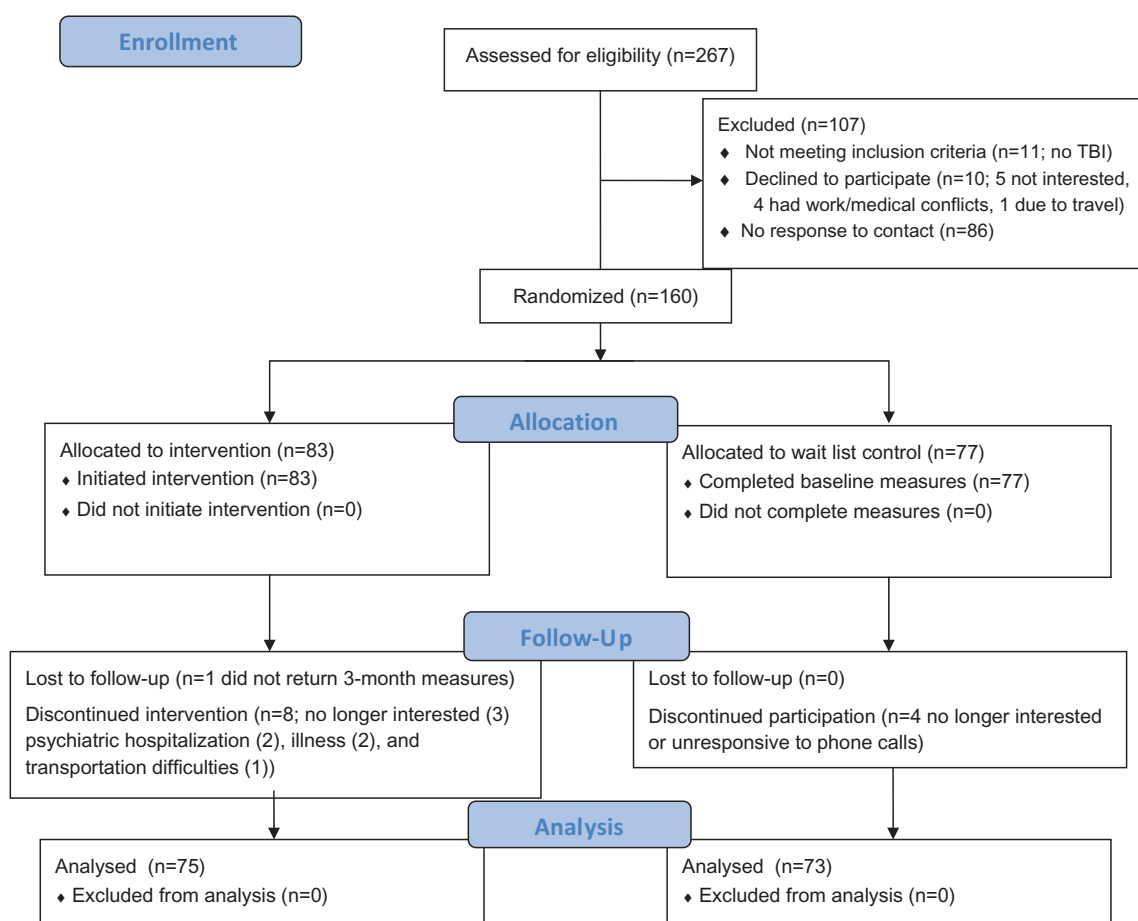
CONSORT Flow Diagram

Figure 1. CONSORT flow diagram.

Table 1. Participant characteristics for the overall sample, RAI group and WLC group.

Characteristic	Overall	RAI (N = 83)	WLC (N = 77)
Gender			
Male	80 (50%)	37 (45%)	43 (56%)
Race			
Non-white	46 (29%)	28 (34%)	18 (23%)
Marital Status			
Married	47 (29%)	20 (24%)	27 (35%)
Residence			
Alone	25 (16%)	13 (16%)	12 (16%)
Education (years)	13 [12–16]	14 [12–16]	13 [12–16]
Occupational Status (preinjury)			
Employed or Student	139 (87%)	72 (87%)	67 (87%)
Unemployed	21 (13%)	11 (13%)	10 (13%)
Occupational Status (baseline postinjury)			
Employed or Student	72 (45%)	33 (40%)	39 (51%)
Unemployed	88 (55%)	50 (60%)	38 (49%)
Injury Severity			
Mild	94 (59%)	51 (61%)	43 (56%)
Moderate/Severe	57 (36%)	26 (31%)	31 (40%)
Unknown	9 (6%)	6 (7%)	3 (4%)
Neurosurgery			
Yes	17 (11%)	7 (8%)	10 (13%)
Age (years)	42 [28–51]	42 [27–51]	42 [29–51]
Length of Hospitalization (days)	5 [0–29]	2 [0–30]	8 [0–24]

All figures are medians and interquartile ranges or frequencies and percentages.
RAI: Resilience and Adjustment Intervention; WLC: Waitlist Control.
No between group differences were observed for RAI vs. WLC.

feedback. Ongoing supervision meetings were held to help maintain intervention integrity.

Measures

The measures chosen for the present investigation were selected because they: (1) were relevant to project objectives and hypotheses; (2) had substantial evidence of reliability and validity; and/or (3) were included in the Common Data Elements (42–44). The Connor-Davidson Resilience Scale (CD-RISC) was selected as the primary outcome measure, with the Mayo-Portland Adaptability Inventory-4 (MPAI-4), Brief Symptom Inventory-18 (BSI-18) and the 13 Item Stress Test serving as secondary outcome measures. There were insufficient data from other studies to establish a quantitative foundation for evaluating the degree of clinically meaningful change from pre- to post-treatment. Consequently, prior to the present investigation, study researchers established clinically significant criteria by consensus for each measure. Additional information regarding each measure follows.

Connor-Davidson Resilience Scale (CD-RISC)

During the past decade, researchers have developed resilience measurement scales, and research suggests that Connor and

Table 2. Overview of RAI sessions, topics and goals.

Session	Topic	Goals: Participants will be able to…
1. Understanding the effects of brain injury	Typical consequences of brain injury	• recount important facts about brain injury recovery • identify which recovery facts would be helpful for their own recovery
	Differences between emotional and physical recovery	• identify which physical and emotional changes have the biggest influence on their recovery • define the terms 'physical recovery' and 'emotional recovery' • describe the differences in physical and emotional recovery patterns • identify common challenges to physical and emotional recovery
	Coping effectively with loss and change	• recognize the common losses after TBI which can lead to grief and loss • understand which losses have impacted their recovery • implement strategies for coping with loss and change
2. Active engagement in recovery	Your important role in recovery	• recognize the importance of taking an active role in the recovery process
	What can you do to help yourself and feel better	• identify areas in their life where they can begin to take a more active role in feeling better
3. Setting reasonable goals	Success is relative	• evaluate how their definition of success has changed since the injury • define the phrase 'flexible definition of success' • identify strategies for developing increasingly flexible definitions of success
	Strategies for being patient	• understand their own feelings about patience in the recovery process • recognize that being patient is an important part of reaching goals in recovery • learn what patience means and identify obstacles to being patient • use strategies for remaining patient on the long road of recovery
	Implementing effective goal-setting strategies	• distinguish between reasonable and unreasonable goals • understand the importance of setting reasonable goals • take steps to set more reasonable and achievable goals
4. Solving problems effectively	Learning and using more effective problem solving strategies	• understand that feeling overwhelmed and having difficulty solving problems are common after a TBI • identify which problem skills they have and which they need to develop • apply new problem solving skills to more effectively address their problems
5. Managing stress, anger and other intense emotions	Managing stress more effectively	• identify the level of stress in their life • understand the reasons that it may be difficult to notice when stress levels rise after a TBI • understand the importance of identifying stress levels in their life • identify strategies that may help to reduce stress
	Managing intense emotions including frustration, anger and fear	• understand the basic characteristics of anger • appreciate the early warning signs of anger and other intense emotions • implement strategies to avoid and better control anger and other intense emotions
6. Communicating effectively and rebuilding relationships	Rebuilding relationships and overcoming loneliness	• recognize that losing relationships is common after brain injury • appreciate what they unknowingly may be doing to undermine relationships in their life • implement ideas they can use to be kind to others
	Effective communication skills	• express ways that communication changes after a TBI • identify challenges they have to effectively communicating • state ideas that can help to improve their communication with others
	Strategies for discussing your injury with others	• understand that insensitive or uncomfortable questions about their injury are common • identify which questions they have been asked that are difficult or upsetting • state how they feel about being asked intrusive questions about their injury • use strategies to minimize the negative impact on relationships that uncomfortable questions can cause

(Continued)

Table 2. (Continued).

Session	Topic	Goals: Participants will be able to…
7. Maintaining a positive outlook	Avoiding a negative focus, feeling guilty and blaming others	• identify the connection between resilience and: a positive focus, feeling good about themselves, and not blaming others for their problems • evaluate how well they do in promoting these resilient traits within themselves • identify the reasons blaming others can hinder recovery • reduce the likelihood they will blame others for their problems • understand the importance of avoiding guilty feelings • recognize how guilty they feel about consequences of their injury • use strategies to feel less guilty
	Positive aspects of your new life and how to develop a positive attitude	• understand the importance of developing a positive outlook and attitude • evaluate their own level of self-esteem • use strategies to focus thinking in positive ways
	Consolidating gains	• describe plans for life change after completing the intervention • identify the positive changes they have made since the programme began

Davidson have been most successful (45,46). The authors first developed a 25-item scale (CD-RISC) reflecting resilience characteristics identified by Kobasa and Rutter (47,48). Normative studies including factor analyses indicated that the CD-RISC is reliable, valid and sensitive to treatment effects (25). More recently, a 10-item version was developed using exploratory and confirmatory factors analyses (49). Respondents are presented with a series of descriptors (e.g., 'I am able to adapt and change', 'Coping with stress can strengthen me') and rate themselves on a 0–4 scale ranging from rarely true (0) to true nearly all the time (4). A total score, ranging 0–40, is calculated with higher scores reflecting greater resilience. Campbell-Sills and colleagues have characterized the 10-item version as demonstrating excellent psychometric properties, namely reliability, internal consistency and construct validity (49,50). For the present investigation, the CD-RISC 10-item version raw score served as the primary outcome measure. Clinical significance was defined as a pre- post-treatment difference of 5 or more points.

Mayo Portland Adaptability Inventory-4 (MPAI-4)

The MPAI-4 is comprised of 30 items rated 0–4, with higher scores indicating greater problem severity. The present investigation included the Adjustment and Ability indices (51). The Adjustment Index items relate to anxiety, depression, irritability, anger, social interaction and self-awareness. The Ability Index includes items relating to verbal and nonverbal communication and problem-solving ability. T-scores are obtained based on norms derived from a brain injury sample. Research has provided evidence of good concurrent, construct and predictive validity, as well as satisfactory internal consistency (51,52). Sensitivity to treatment-related change has also been substantiated (53). Clinical significance was defined as a pre- post-treatment difference of 5 or more points.

13-item stress test

This self-report measure was developed more than a decade ago for clinical research studies on stress management with survivors and caregiving family members (54). Sample items include, 'I have more to do than I can handle', 'I'm pushing myself too hard' and 'I can't stand living like this'. Items are rated as True (1) or False (0). Stress levels are indicated by the total score, ranging 0–13 with higher scores indicating higher stress levels (55). The measure has been shown to be sensitive to family intervention after TBI (56,57). The total score was included in the present investigation. Clinical significance was defined as a pre- post-treatment difference of 2 or more points.

Brief Symptom Inventory-18 (BSI-18)

This 18-item self-report instrument is the abbreviated version of the Symptom Checklist-90-Revised (SCL-90-R) developed to quantify psychological distress in the general population (58). A number of investigators have used the measure to quantify distress after TBI. In particular, researchers have used the BSI-18 to monitor change in psychological status in response to treatment (59) and general change in status over time (60). The BSI-18 is often used because of its sound psychometric properties (58), brevity, ease of administration and global assessment of psychological issues commonly found in individuals with TBI (43). The Global Severity Index (GSI) reflects the sum of scores for three symptom dimensions (i.e., Anxiety, Depression, Somatization) and conveys overall distress levels. T-scores are calculated based on community norms. A study examining the psychometric properties of the GSI with a TBI sample characterized the GSI as having good internal consistency with excellent reliability and validity (61). Clinical significance was defined as a pre- post-treatment difference of 5 or more points.

Sample size

Assuming a conservative standard deviation (SD) of 10.5 for the CD-RISC, 64 individuals per group were required to obtain at least 80% power to detect a difference of 5 points in the baseline to post-treatment changes between the two groups using a two-sample t-test and assuming a significance level of 0.05. Similar effect sizes were assumed for secondary outcomes (MPAI-4 Adjustment, MPAI-4 Ability, BSI-18), while a clinically significant difference of 2 points along with a SD of 4.2 were assumed for the 13-item Stress Test.

Procedures

Participants with TBI were referred by rehabilitation providers, organizations and agencies. Screening, assessment and intervention were completed in an outpatient clinic attached to a major medical centre. During the intake session, project staff (the project coordinator and research associates) provided an overview of the research programme, confirmed interest in participation and eligibility, and obtained informed consent. Prior to initiation, this study was approved by the university's institutional review board. The trial was registered with ClinicalTrials.gov (NCT01935583). No procedural changes were made in the protocol following study implementation.

On giving informed consent, the participant was given baseline assessment materials to complete and was randomized to either the RAI or control group, based on a computer-generated table. Control group participants were scheduled to return in 5 weeks to complete a second assessment. For practical reasons, the second assessment is labelled as the 'post-treatment assessment' in later sections of the manuscript. Controls were offered an opportunity to complete the intervention following the second assessment as a courtesy.

With regard to the treatment group, a therapist worked individually with each person through the intervention. The seven sessions were completed over a 5-week period. Participants were asked to complete worksheets and review and discuss materials with friends and family between sessions. Post-treatment data were collected following the final session. Three month follow-up data were collected 10–14 weeks following the last session. For practical reasons, project staff were not blinded to group assignment.

Data analysis

Medians and interquartile ranges or frequencies and percentages were used to summarize the demographic and injury characteristics of the sample. Similar summaries were calculated for each of the RAI and WLC groups. Means and SDs were used to summarize the primary (CD-RISC) and secondary (MPAI-4 Adjustment, MPAI-4 Ability, BSI-18, 13-item Stress Test) outcomes separately at baseline, post-treatment, and, for the RAI group, follow-up. A linear mixed effect model was used to model each outcome, with the time point (Baseline, Post-Treatment, Follow-up), treatment and the interaction as explanatory variables. The model follows the intent-to-treat principle by allowing for participants' information to be included in the statistical analysis when available and produces valid estimates under the missing at random or missing completely at random assumptions (62). Each of these models was also adjusted for participant education level, time post injury and injury severity. A spatial auto-correlation covariance structure was used to induce dependence within an individual and accounted for the different lengths of treatment and follow-up within an individual. Specific contrasts were used to test the primary hypothesis that the RAI group had a more favourable change from baseline compared to the control group. A separate contrast was used to assess the secondary hypothesis that, within the subjects randomized to the RAI, the outcomes were more favourable at the follow-up measurement compared to the baseline measurement.

Results

For the RAI group, the average time from treatment initiation to completion was 54 days (SD = 36, Range: 11–183) while the time until follow-up averaged 100 days after treatment initiation (SD = 13.8, Range: 77–155). The WLC group had a mean time of 44 days (SD = 18, Range: 25–157) between first and second baseline measurements. Additional demographic and injury information can be seen in Table 1. No statistically significant differences in any of the demographic or injury characteristics were observed between the RAI and WLC groups ($p > .05$).

Means and SDs for outcome measures at each time interval are provided in Table 3. No statistical differences were discovered at baseline between the two groups ($p > .05$). Improvement in all outcomes was observed between pre-treatment and post-treatment time points for the RAI group. Similarly, improvements in all measures were evident between baseline and 3 month follow-up. Measures for the WLC group remained relatively unchanged.

After adjusting for injury severity, education and time since injury, the RAI group demonstrated a significantly higher increase in resilience compared to the WLC group (Table 4). Specifically, the CD-RISC scores demonstrated a 6.70 (95% CI: 4.96, 8.43) point higher increase in the RAI group compared to the WLC group. Notably, this increase was greater than the 5-point difference that was *a priori* considered clinically significant. A graphical representation of the difference is shown in Figure 2.

In addition to higher resilience in the clinical intervention group, the participants who completed the RAI demonstrated

Table 3. Baseline, post-treatment and follow-up means and standard deviations for outcome measures.

Outcome	Group	Baseline	Post-treatment	Follow-up
CD-RISC*	RAI	21.1 (8.1)	28.4 (6.9)	25.5 (7.8)
	WLC	23.4 (9.0)	23.7 (8.1)	–
MPAI-4: Adjustment Index†	RAI	55.4 (9.1)	51.2 (9.5)	50.7 (10.0)
	WLC	55.8 (10.5)	54.5 (9.2)	–
MPAI-4: Ability Index†	RAI	55.0 (9.7)	51.0 (8.3)	50.7 (9.5)
	WLC	53.5 (10.8)	54.2 (9.5)	–
BSI-18†	RAI	63.8 (11.7)	57.2 (10.6)	58.7 (10.4)
	WLC	64.1 (10.7)	64.0 (9.4)	–
13-Item Stress*	RAI	6.7 (3.3)	4.5 (3.4)	5.0 (3.1)
	WLC	6.5 (3.5)	6.0 (3.3)	–

* Raw score.
† T-score.
RAI: Resilience and Adjustment Intervention; WLC: Waitlist Control; CD-RISC: Connor-Davidson Resilience Scale; MPAI-4: Mayo-Portland Adaptability Inventory-4; BSI-18: Brief Symptom Inventory-18.

Table 4. Post-treatment outcome measurement differences between RAI and WLC groups.

Outcome	RAI–WLC at post-treatment		
	Difference (95% CI)	ES (d)	p
CD-RISC	6.70 (4.96, 8.43)	1.03	<0.001
MPAI-4: Adjustment Index	−2.48 (−4.55, −0.41)	−0.32	0.019
MPAI-4: Ability Index	−3.75 (−5.85, −1.65)	−0.48	<0.001
BSI-18	−6.51 (−8.73, −4.30)	−0.78	<0.001
13-Item Stress Test	−1.50 (−2.23, −0.77)	−0.55	<0.001

RAI: Resilience and Adjustment Intervention; WLC: Waitlist Control; ES: Effect size; CD-RISC: Connor-Davidson Resilience Scale; MPAI-4: Mayo-Portland Adaptability Inventory-4; BSI-18: Brief Symptom Inventory-18.
With the exception of the CD-RISC, higher scores denote worse functioning.
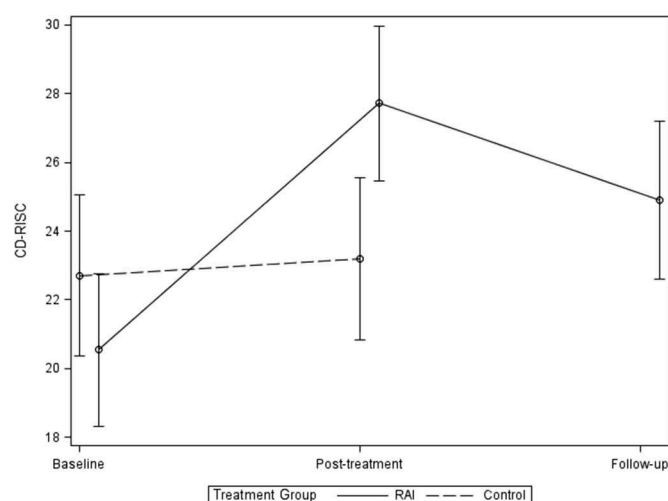
Figure 2. Estimated CD-RISC scores after adjusting for participant education level, time post injury and injury severity. Bounds on the estimates correspond to 95% CIs.

Table 5. Baseline to follow-up outcome measurement differences for the RAI group.

Outcome	Follow-up–Baseline for RAI		
	Difference (95% CI)	ES (d)	p
CD-RISC	4.36 (2.42, 6.30)	0.60	<0.001
MPAI-4: Adjustment Index	−4.61 (−6.95, −2.27)	−0.53	<0.001
MPAI-4: Ability Index	−4.05 (−6.41, −1.69)	−0.46	<0.001
BSI-18	−5.01 (−7.52, −2.50)	−0.53	<0.001
Stress	−1.60 (−2.40, −0.81)	−0.54	<0.001

RAI: Resilience and Adjustment Intervention; WLC: Waitlist Control; ES: Effect size; CD-RISC: Connor-Davidson Resilience Scale; MPAI-4: Mayo-Portland Adaptability Inventory-4; BSI-18: Brief Symptom Inventory-18.
With the exception of the CD-RISC, higher scores denote worse functioning.

more favourable scores on the MPAI-4 Adjustment Index, MPAI-4 Ability Index, BSI-18 and the 13-item Stress Test (Table 4). However, only the BSI-18 demonstrated a difference that exceeded the clinical significance level of 5 units (Diff = −6.51, 95% CI: −8.73, −4.30).

Participants who completed the RAI had significantly improved scores for all outcomes when comparing the follow-up measures to baseline ($p < 0.05$) (Table 5). However, only the BSI-18 achieved a difference that was deemed clinically significant (Diff = −5.01, 95%CI: −7.52, −2.50).

Discussion

In a randomized controlled trial, the present investigation added to the small but growing body of literature focused on resilience by examining the benefits of a manualized intervention programme designed to promote resilience and adjustment following TBI. Borrowing from the field of positive psychology (63), the investigation was unique in the rehabilitation field. Rather than focusing on personal limitations and impairments, intervention focused on skill-building and positive attributes. In addition, the present investigation is, to date, the only study to examine the benefits of an intervention specifically designed to enhance resilience. Four hypotheses were offered. The first hypothesis asserted treatment group participants would show an increase in resilience relative to WLCs, as measured by the CD-RISC, the primary

outcome measure. The hypothesis was fully supported, with both statistical and clinically meaningful differences.

The second hypothesis asserted that participants in the treatment group would show better emotional adjustment and lower levels of distress in comparison to WLCs, as measured by the MPAI-4 Adjustment Index and BSI-18. Statistically, the hypothesis was substantiated. Clinically, the hypothesis was only partly supported. Whereas clinically meaningful differences in emotional distress were found for the treatment group, changes in levels of emotional adjustment were not clinically meaningful.

The third hypothesis asserted that treatment group participants would report greater abilities in the areas of problem solving, communication and stress management relative to persons in the WLC group, as measured by the MPAI-4 Ability Index and 13 Item Stress Test. As with the second hypothesis, statistical significance was found. However, differences were not clinically meaningful.

The final hypothesis asserted that treatment group participants would show sustained improvements in resilience, emotional distress, adjustment and abilities 3 months following completion of treatment. Statistically, maintenance of gains was found for all outcome measures. A priori, investigators had defined clinical significance for the CD-RISC, MPAI-4 and BSI-18 as a 5-point difference. In fact, difference scores for the measures ranged from 4.05 to 5.01 with only the BSI-18 meeting the criteria for clinical significance. The difference score for the 13-item Stress Test was 1.60, nearly meeting the criterion for clinical significance (2.0).

Over the past five years, researchers have begun a concerted effort to explore resilience after TBI. There is an emerging consensus that resilience is compromised after injury and that lower resilience is associated with poor psychological outcomes (21,27,30–32). The present investigation indicates that resilience can be improved postinjury by strengthening fundamental skills such as problem solving, emotion management and communication. Results also indicate that targeting resilience results in reduced emotional distress. Numerous studies have shown that improved emotional health is associated with better functional outcomes postinjury, including social integration and return to work (64–67). Thus, this study offers promise for promoting holistic gains that may transfer to improved productivity and general well-being.

There are several limitations worth discussing. While the findings are positive, the intervention may benefit from honing to enhance efficacy. The intervention was conducted at a single centre, raising questions about generalizability. A multi-centre investigation could offer more convincing evidence of treatment efficacy. The present design did not include an active control group which would have allowed for comparisons between participants receiving standard care and those receiving the RAI. Inclusion of an active control group is an important consideration for the design of future studies. Uncertainties remain about the durability of treatment effects, as long-term outcome was limited to 3 months post-treatment. Although two measures showed clinically meaningful benefits at post-treatment, only one showed maintenance of meaningful gains at 3 month follow-up. Future research should consider the value of 'booster' sessions, implemented to extend the intervention's impact. Hsieh and colleagues

have demonstrated the benefits of booster sessions in their research on anxiety reduction after brain injury (68).

In conclusion, the present investigation provided evidence that a curriculum-based education, skill-building and support intervention can improve resilience and reduce psychological distress in individuals with TBI. Additional research is needed to ascertain the longer term benefits of intervention and the efficacy of alternative delivery methods (e.g., via telephone, Internet).

Declaration of Interest

The authors report no conflicts of interest.

Funding

References

1. Ruttan L, Martin K, Liu A, Colella B, Green RE. Long-term cognitive outcome in moderate to severe traumatic brain injury: a meta-analysis examining timed and untimed tests at 1 and 4.5 or more years after injury. Arch Phys Med Rehabil. 2008;89(12 Suppl):S69–76.
2. Konigs M, Engenhorst PJ, Oosterlaan J. Intelligence after traumatic brain injury: meta-analysis of outcomes and prognosis. Eur J Neurol. 2016;23(1):21–29.
3. Anson K, Ponsford J. Coping and emotional adjustment following traumatic brain injury. J Head Trauma Rehabil. 2006;21(3):248–59.
4. Spitz G, Schonberger M, Ponsford J. The relations among cognitive impairment, coping style, and emotional adjustment following traumatic brain injury. J Head Trauma Rehabil. 2013;28(2):116–25.
5. Rao V, Koliatsos V, Ahmed F, Lyketsos C, Kortte K. Neuropsychiatric disturbances associated with traumatic brain injury: a practical approach to evaluation and management. Semin Neurol. 2015;35(1):64–82.
6. Zgaljardic DJ, Seale GS, Schaefer LA, Temple RO, Foreman J, Elliott TR. Psychiatric disease and post-acute traumatic brain injury. J Neurotrauma. 2015;32(23):1911–25.
7. Wood RL, Rutterford NA. Demographic and cognitive predictors of long-term psychosocial outcome following traumatic brain injury. J Int Neuropsychol Soc. 2006;12(3):350–58.
8. Williams MW, Rapport LJ, Millis SR, Hanks RA. Psychosocial outcomes after traumatic brain injury: life satisfaction, community integration, and distress. Rehabil Psychol. 2014;59(3):298–305.
9. Rohling ML, Faust ME, Beverly B, Demakis G. Effectiveness of cognitive rehabilitation following acquired brain injury: a meta-analytic re-examination of cicerone et al.'s (2000, 2005) systematic reviews. Neuropsychol. 2009;23(1):20–39.
10. Kennedy MR, Coelho C, Turkstra L, Ylvisaker M, Moore Sohlberg M, Yorkston K, Chiou HH, Kan PF. Intervention for executive functions after traumatic brain injury: a systematic review, meta-analysis and clinical recommendations. Neuropsychol Rehabil. 2008;18(3):257–99.
11. Snell DL, Surgenor LJ, Hay-Smith EJC, Siegert RJ. A systematic review of psychological treatments for mild traumatic brain injury: an update on the evidence. J Clin Exp Neuropsychol. 2009;31(1):20–38.
12. Bergquist TF, Thompson K, Gehl C, Munoz Pineda J. Satisfaction ratings after receiving internet-based cognitive rehabilitation in persons with memory impairments after severe acquired brain injury. Telemed J E Health. 2010;16(4):417–23.
13. Bradbury CL, Christensen BK, Lau MA, Ruttan LA, Arundine AL, Green RE. The efficacy of cognitive behavior therapy in the treatment of emotional distress after acquired brain injury. Arch Phys Med Rehabil. 2008;89(12):S61–S68.
14. Bell KR, Brockway JA, Hart T, Whyte J, Sherer M, Fraser RT, Temkin NR, Dikmen SS. Scheduled telephone intervention for traumatic brain injury: a multicenter randomized controlled trial. Arch Phys Med Rehabil. 2011;92(10):1552–60.
15. Vikane E, Hellstrom T, Roe C, Bautz-Holter E, Assmus J, Skouen JS. Multidisciplinary outpatient treatment in patients with mild traumatic brain injury: a randomised controlled intervention study. Brain Inj. 2017;31(4):1–10.
16. Bell KR, Fann JR, Brockway JA, Cole WR, Bush NE, Dikmen S, Hart T, Lang AJ, Grant G, Gahm G, et al. Telephone problem solving for service members with mild traumatic brain injury: a randomized, clinical trial. J Neurotrauma. 2017;34(2):313–21.
17. Gordon WA, Zafonte R, Cicerone K, Cantor J, Brown M, Lombard L, Goldsmith R, Chandna T. Traumatic brain injury rehabilitation: state of the science. Am J Phys Med Rehabil. 2006;85(4):343–82.
18. Whyte J, Hart T. It's more than a black box; it's a Russian doll: defining rehabilitation treatments. Am J Phys Med Rehabil. 2003;82(8):639–52.
19. Whyte J, Barrett AM. Advancing the evidence base of rehabilitation treatments: a developmental approach. Arch Phys Med Rehabil. 2012;93(8 Suppl):S101–10.
20. White B, Driver S, Warren AM. Considering resilience in the rehabilitation of people with traumatic disabilities. Rehabil Psychol. 2008;53(1):9–17.
21. Lukow HR 2nd, Godwin EE, Marwitz JH, Mills A, Hsu NH, Kreutzer JS. Relationship between resilience, adjustment, and psychological functioning after traumatic brain injury: a preliminary report. J Head Trauma Rehabil. 2015;30(4):241–48.
22. Newman R. APA's resilience initiative. Prof Psychol: Res Pract. 2005;36(3):227–29.
23. Luthar SS, Cicchetti D, Becker B. The construct of resilience: a critical evaluation and guidelines for future work. Child Dev. 2000;71(3):543–62.
24. Richardson GE. The metatheory of resilience and resiliency. J Clin Psychol. 2002;58(3):307–21.
25. Connor KM, Davidson JRT. Development of a new resilience scale: the Connor-Davidson resilience scale (CD-RISC). Depress Anxiety. 2003;18(2):76–82.
26. Ungar M. Resilience, trauma, context, and culture. Trauma Violence Abuse. 2013;14(3):255–66.
27. Kreutzer JS, Marwitz JH, Sima AP, Bergquist TF, Johnson-Greene D, Felix ER, Whiteneck GG, Dreer LE. Resilience following traumatic brain injury: a traumatic brain injury model systems study. Arch Phys Med Rehabil. 2016;97(5):708–13.
28. Hanks RA, Rapport LJ, Waldron Perrine B, Millis SR. Correlates of resilience in the first 5 years after traumatic brain injury. Rehabil Psychol. 2016;61(3):269–76.
29. Losoi H, Silverberg ND, Waljas M, Turunen S, Rosti-Otajärvi E, Helminen M, Luoto TM, Julkunen J, Öhman J, Iverson GL. Recovery from mild traumatic brain injury in previously healthy adults. J Neurotrauma. 2016;33(8):766–76.
30. Losoi H, Waljas M, Turunen S, Brander A, Helminen M, Luoto TM, Rosti-Otajärvi E, Julkunen J, Öhman J. Resilience is associated with fatigue after mild traumatic brain injury. J Head Trauma Rehabil. 2015;30(3):E24–32.
31. Losoi H, Silverberg ND, Waljas M, Turunen S, Rosti-Otajärvi E, Helminen M, Luoto TM, Julkunen J, Öhman J, Iverson GL. Resilience is associated with outcome from mild traumatic brain injury. J Neurotrauma. 2015;32(13):942–49.
32. Sullivan KA, Edmed SL, Allan AC, Smith SS, Karlsson LJ. The role of psychological resilience and mTBI as predictors of postconcussional syndrome symptomatology. Rehabil Psychol. 2015;60(2):147–54.

33. Sullivan KA, Kempe CB, Edmed SL, Bonanno GA. Resilience and other possible outcomes after mild traumatic brain injury: a systematic review. Neuropsychol Rev. 2016;26(2):173–85.

34. Godwin EE, Kreutzer JS. Embracing a new path to emotional recovery: adopting resilience theory in post-TBI psychotherapy. Brain Inj. 2013;27(6):637–39.

35. Holland JN, Schmidt AT. Static and dynamic factors promoting resilience following traumatic brain injury: a brief review. Neural Plast. 2015;2015:902802.

36. Ellis A. A new guide to rational living. Englewood Cliffs, NJ: Prentice Hall; 1975.

37. Mateer CA, Sira CS, O'Connell ME. Putting humpty dumpty together again: the importance of integrating cognitive and emotional interventions. J Head Trauma Rehabil. 2005;20(1):62–75.

38. Mateer CA, Sira CS. Cognitive and emotional consequences of TBI: intervention strategies for vocational rehabilitation. NeuroRehabilitation. 2006;21(4):315–26.

39. Hodgson J, McDonald S, Tate R, Gertler P. A randomized controlled trial of a cognitive-behavioural therapy program for managing social anxiety after acquired brain injury. Brain Impairment. 2005;6:169–80.

40. Kreutzer J, Godwin E, Wilder-Schaaf K, Wetsel M. Getting better (and better) after brain injury: the survivor's guide for living smarter and happier. 2nd ed. Richmond, VA: The National Resource Center for Traumatic Brain Injury; 2012.

41. Kreutzer JS, Godwin EE, Marwitz JH. Resilience and adjustment intervention implementation manual. Richmond, VA: National Resource Center for Traumatic Brain Injury; 2014.

42. Maas AI, Harrison-Felix CL, Menon D, Adelson PD, Balkin T, Bullock R, Engel DC, Gordon W, Langlois-Orman J, Lew HL, et al. Standardizing data collection in traumatic brain injury. J Neurotrauma. 2011;28(2):177–87.

43. Wilde EA, Whiteneck GG, Bogner J, Bushnik T, Cifu DX, Dikmen S, French L, Giacino JT, Hart T, Malec JF, et al. Recommendations for the use of common outcome measures in traumatic brain injury research. Arch Phys Med Rehabil. 2010;91(11):1650–60.

44. Thurmond VA, Hicks R, Gleason T, Miller AC, Szuflita N, Orman J, Schwab K. Advancing integrated research in psychological health and traumatic brain injury: common data elements. Arch Phys Med Rehabil. 2010;91(11):1633–36.

45. Windle G, Bennett KM, Noyes J. A methodological review of resilience measurement scales. Health Qual Life Outcomes. 2011;9:8–25.

46. Cosco TD, Kaushal A, Richards M, Kuh D, Stafford M. Resilience measurement in later life: a systematic review and psychometric analysis. Health Qual Life Outcomes. 2016;14:16–016-0418–6.

47. Kobasa SC. Stressful life events, personality, and health: an inquiry into hardiness. J Pers Soc Psychol. 1979;37(1):1–11.

48. Rutter M. Resilience in the face of adversity. protective factors and resistance to psychiatric disorder. Br J Psychiatry. 1985;147:598–611.

49. Campbell-Sills L, Stein MB. Psychometric analysis and refinement of the Connor-Davidson resilience scale (CD-RISC): validation of a 10-item measure of resilience. J Trauma Stress. 2007;20(6):1019–28.

50. Campbell-Sills L, Forde DR, Stein MB. Demographic and childhood environmental predictors of resilience in a community sample. J Psychiatr Res. 2009;43(12):1007–12.

51. Malec JF, Lezak MD. The Mayo-Portland adaptability inventory (MPAI-4) for adults, children and adolescents. Rochester, MN: Mayo Clinic; 2008.

52. Malec JF, Moessner AM, Kragness M, Lezak MD. Refining a measure of brain injury sequelae to predict postacute rehabilitation outcome: rating scale analysis of the mayo-portland adaptability inventory. J Head Trauma Rehabil. 2000;15(1):670–82.

53. Eicher V, Murphy MP, Murphy TF, Malec JF. Progress assessed with the Mayo-Portland adaptability inventory in 604 participants in 4 types of post-inpatient rehabilitation brain injury programs. Arch Phys Med Rehabil. 2012;93(1):100–07.

54. Kreutzer JS, Kolakowsky-Hayner SA, Demm SR, Meade MA. A structured approach to family intervention after brain injury. J Head Trauma Rehabil. 2002;17(4):349–67.

55. Kreutzer JS, Kolakowsky-Hayner SA. Getting better (and better) after brain injury: a guide for family, friends, and caregivers. Richmond, VA: National Resource Center for Traumatic Brain Injury; 1999.

56. Kreutzer JS, Stejskal TM, Ketchum JM, Marwitz JH, Taylor LA, Menzel JC. A preliminary investigation of the brain injury family intervention: impact on family members. Brain Inj. 2009;23 (6):535–47.

57. Kreutzer JS, Stejskal TM, Godwin EE, Powell VD, Arango-Lasprilla JC. A mixed methods evaluation of the brain injury family intervention. NeuroRehabilitation. 2010;27(1):19–29.

58. Derogatis LR. Brief symptom inventory (BSI) 18: administration, scoring and procedures manual. Minneapolis, MN: NCS Pearson, Inc.; 2000.

59. Thaut MH, Gardiner JC, Holmberg D, Horwitz J, Kent L, Andrews G, Donelan B, McIntosh GR. Neurologic music therapy improves executive function and emotional adjustment in traumatic brain injury rehabilitation. Ann N Y Acad Sci. 2009;1169 (1):406–16.

60. Dikmen SS, Machamer JE, Powell JM, Temkin NR. Outcome 3 to 5 years after moderate to severe traumatic brain injury. Arch Phys Med Rehabil. 2003;84(10):1449–57.

61. Meachen SJ, Hanks RA, Millis SR, Rapport LJ. The reliability and validity of the brief symptom inventory-18 in persons with traumatic brain injury. Arch Phys Med Rehabil. 2008;89(5):958–65.

62. Cnaan A, Laird NM, Slasor P. Using the general linear mixed model to analyse unbalanced repeated measures and longitudinal data. Stat Med. 1997;16(20):2349–80.

63. Evans J. Positive psychology brain injury rehabilitation. Brain Impair. 2011;12(2):117–27.

64. Bombardier CH, Fann JR, Temkin NR, Esselman PC, Barber J, Dikmen SS. Rates of major depressive disorder and clinical outcomes following traumatic brain injury. JAMA. 2010;303 (19):1938–45.

65. Whelan-Goodinson R, Ponsford JL, Schonberger M, Johnston L. Predictors of psychiatric disorders following traumatic brain injury. J Head Trauma Rehabil. 2010;25(5):320–29.

66. Hart T, Benn EK, Bagiella E, Arenth P, Dikmen S, Hesdorffer DC, Novack TA, Ricker JH, Zafonte R. Early trajectory of psychiatric symptoms after traumatic brain injury: relationship to patient and injury characteristics. J Neurotrauma. 2014;31(7):610–17.

67. Hart T, Brenner L, Clark AN, Bogner JA, Novack TA, Chervoneva I, Nakase-Richardson R, Arango-Lasprilla JC. Major and minor depression after traumatic brain injury. Arch Phys Med Rehabil. 2011;92(8):1211–19.

68. Hsieh MY, Ponsford J, Wong D, Schonberger M, Taffe J, McKay A. Motivational interviewing and cognitive behaviour therapy for anxiety following traumatic brain injury: a pilot randomised controlled trial. Neuropsychol Rehabil. 2012;22(4):585–608.